Original Article

Tooth Width Ratios in Crowded and Noncrowded Dentitions

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Abstract: Discrepancies in tooth width ratios could affect the excellence in the finishing of orthodontic cases. This study compares tooth width ratios in crowded and noncrowded dental arches. Tooth widths were measured from 143 dental casts (40 crowded and 33 spaced in male individuals and 43 crowded and 27 spaced in female individuals). Simultaneous crowded or spaced arches were selected. Tooth width measurements were made with a sliding caliper with a Vernier scale neared 0.1 mm. Inter- (0.990) and intraexaminer (0.993) reliability with mean differences of 0.03 mm (−0.03; 0.07) and 0.01 mm (−0.04; 0.05), respectively, were attained. Bolton analysis was applied to calculate the tooth width ratios (anterior and total). Descriptive statistics, Student's *t*-test, and analysis of variance were applied. There was no significant difference between the anterior and total tooth width ratios according to sex ($P > .05$). Both anterior and total ratios were significantly greater in subjects with crowding ($P = .003$ and $P = .026$, respectively), but no statistical difference by arch type in anterior and total tooth mass excess was found ($P > .05$). Differences among subjects with noncrowded and crowded dentitions were of 0.39 and 0.51 mm for the excess of anterior and total upper tooth mass, respectively, with respect to lower mass excess. Although the anterior and overall ratios and the differences between the upper and lower tooth width sums are greater in subjects with crowding, no clinically significant difference is observed (less than one mm). (*Angle Orthod* 2004;74:765–768.)

Key Words: Tooth width ratio; Bolton proportion; Crowding; Clinical significance

INTRODUCTION

It is known that several etiologic factors are associated individually or in groups to dental crowding in the permanent dentition.[1] Mesiodistal tooth width is considered a primordial etiologic factor in space anomalies, which together with tooth width discrepancy may cause malocclusion.[2–4]

Even though differences between mesiodistal tooth width in crowded and noncrowded dentitions have been reported in several studies,[2,5–11] only few of these analyzed mesiodistal tooth width collectively instead of individually.[2,6–8] Lündstrom[2] did not find differences with his proposed tooth width ratio (index S) and the amount of crowding, but his sample size of noncrowded cases was small. Norderval et al[6] showed that Bolton anterior ratio was significantly higher in the group with lower incisal crowding compared with the group with good alignment. Adams[8] found significant differences in the total tooth width sums of the upper and lower arches between crowded and noncrowded dentitions. He did not compare tooth width ratios.

It is expected that less than ideal occlusal relationships should exist in cases with significant tooth width ratios.[4] In the literature, only Lündstrom's[2] study previously evaluated the relationship between total tooth width ratio and crowding, but with sample size limitations, and Norderval et al[6] only for the anterior tooth width ratio. Because dental crowding should be associated to larger tooth width to a certain degree, it is probable that disproportions in the interarch tooth width relationship in the posterior arch area may also influence the presence of dental crowding. Discrepancies in tooth width could affect the excellence in the finishing of orthodontic cases. Therefore, this study was designed to evaluate tooth width ratios in crowded and noncrowded dentitions and discuss the clinical implications of the possible differences.

MATERIALS AND METHODS

From 321 dental casts of schoolchildren between 12 and 16 years with permanent dentition, completely erupted 143 dental casts were selected according to dental arch discrep-

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ancy. All the dental casts had been free of dental caries, restorations, or attrition in proximal surfaces or any anomaly in tooth number, size, or shape. Dental arch discrepancy was considered as the difference between the available and required space in each dental arch. Presence of any negative discrepancy in both arches was considered a crowded case and presence of any positive discrepancy in both arches as a noncrowded case. They were divided into four groups according to crowding and sex (73 male individuals, of which 40 presented crowding, and 70 female individuals, of which 43 presented crowding).

Mesiodistal tooth size of each tooth was measured by using a sliding caliper with Vernier scale neared to 0.1 mm according to the technique proposed by Moorrees et al[12] and Moorrees and Reed[13] To minimize random and systematic errors, all measurements were performed by a single examiner, who was calibrated previously,[14,15] by measuring only eight to ten pairs of models each day to avoid visual fatigue.[14] For the main study, the primary investigator measured each tooth twice, from the right first molar to the left first molar in each arch. If the difference between both was less than 0.2 mm, the first measurement was registered. If the second measure differed more than 0.2 mm from the first measure, then the tooth was measured again,[16–18] and only the new measure was then registered.[18]

Reliability analysis for intra- and interexaminer calibration was evaluated using intraclasses correlation coefficient and paired-samples *t*-test. The intraclasses correlation coefficient for mesiodistal tooth size was slightly higher for the intraexaminer reliability (0.993) than the interexaminer reliability (0.990). Measurement errors were very similar in both cases, with mean differences of 0.03 mm (−0.03; 0.07) and 0.01 mm (−0.04; 0.05). Paired-samples *t*-test supported the null hypothesis that there was no difference between the mean of the first and second measurements ($P = .080$ and .826, respectively).

Tooth width ratios were calculated in the four groups using formulas proposed by Bolton[3,4] and then compared using a univariate two-way analysis of variance (ANOVA) once normality and homoscedasticity suppositions were corroborated. Independent-samples *t*-test was used to compare differences between the mean sum of the (anterior and total) maxillary tooth widths and the sum of the (anterior and total) mandibular tooth widths among both types of dental arches. Finally, anterior and overall ratios were grouped according to differences in standard deviations (SD) from Bolton proposed mean values. Chi-square test (or Fisher exact test as an alternative when the expected frequencies were less than five) was used to determine where the differences between types of arches lay.

RESULTS

Table 1 exhibits descriptive statistics (mean, SD, and minimum and maximum values) of the tooth width ratios for the groups according to sex and dentition type. The results of Kolmogov-Smirnov and Levene tests demonstrated the accomplishment of the suppositions of normality ($P > .542$ for the anterior ratio and $P > .653$ for the total ratio) and homoscedasticity ($P = .330$ for the anterior ratio and $P = .373$ for the total ratio), which allowed comparison between tooth width ratios among the four groups with parametric tests. ANOVA found that both ratios (anterior and total) were higher in adolescents with crowded dentition ($P = .003$ and $P = .026$, respectively). Neither differences for sex nor differences for the interaction between sex and crowding were found.

TABLE 1. Tooth Size Discrepancies in Crowded and Noncrowded Dentitions

	Crowded Dentition		Noncrowded Dentition	
	Male	Female	Male	Female
n	40	43	27	33
Anterior ratio				
Mean	78.85	77.98	76.97	77.27
Standard deviation	2.82	2.36	1.83	2.59
Minimum	72.59	73.31	73.23	71.63
Maximum	85.08	85.71	81.09	84.47
Overall ratio				
Mean	91.52	90.88	90.23	90.68
Standard deviation	2.03	1.72	1.55	2.08
Minimum	88.06	86.47	87.49	86.40
Maximum	96.55	93.55	93	95.27

A comparison between crowded and noncrowded dentitions of the frequencies of the anterior ratios and total ratios grouped according to the number of SDs from the mean proposed by Bolton are presented in Table 2. For the anterior ratio, only when the ratio was between the mean and −1 SD and between one and two SD, the difference between crowded and noncrowded dentitions was significant ($P = .05$ and $P = .009$, respectively). For the total ratio, only when the ratio was between one and two SD, the difference between crowded and noncrowded dentitions was significant ($P = .002$).

The mean sum of the six maxillary anterior tooth widths exceed the sum of the six mandibular anterior tooth widths by 10.59 mm for crowded dentition and by 10.98 mm for noncrowded dentitions. Independent-samples *t*-test demonstrated that the difference between both groups was not statistically significant (0.396 mm; $P = .115$). Similarly, the sum of the 12 maxillary tooth widths exceeded the sum of the 12 mandibular tooth widths by 8.87 mm for crowded dentition and by 9.38 mm in adolescents for noncrowded dentition. Independent-samples *t*-test demonstrated that this difference was also not statistically significant (0.509 mm; $P = .133$) (Table 3).

TABLE 2. Comparison Tooth Size Discrepancies Grouped According to Standard Deviations from Bolton Proposed Mean Values in Crowded and Noncrowded Dentitions

	Anterior Ratio			Total Ratio		
Number of Standard Deviations from Bolton Mean Values	Crowded (n = 83)	Noncrowded (n = 60)	Significance	Crowded (n = 83)	Noncrowded (n = 60)	Significance
Less than −2SD	4 (4.8%)	3 (5.0%)	.626*	1 (1.2%)	3 (5.0%)	.199*
Between −1SD and −2SD	7 (8.4%)	10 (16.7%)	.133	16 (19.3%)	13 (21.7%)	.726
Between Bolton mean and −1SD	17 (20.5%)	21 (35.0%)	.05	25 (30.1%)	23 (38.3%)	.305
Between Bolton mean and +1SD	15 (18.1%)	14 (23.3%)	.44	28 (33.7%)	19 (31.7%)	.795
Between +1SD and +2SD	25 (30.1%)	7 (11.7%)	.009	12 (14.5%)	0 (0.0%)	.002
More than +2SD	15 (18.1%)	5 (8.3%)	.098	1 (1.2%)	2 (3.3%)	.380*

* Fisher exact test was used.

TABLE 3. Mean Sum of the Mesiodistal Tooth Size in Crowded and Noncrowded Dentitions

		Maxilla		Mandible		Mean Difference		
Sum	Dental Arch	Mean	SD	Mean	SD	Mean	SD	*P*
Anterior	Noncrowded	47.97	2.32	36.99	1.84	10.98	1.33	.115
	Crowded	48.86	2.67	38.28	1.91	10.59	1.64	
Overall	Noncrowded	98.65	4.01	89.27	3.76	9.38	1.94	.133
	Crowded	100.43	4.61	91.56	4.17	8.87	2.05	

DISCUSSION

This study compared tooth width ratios in 143 adolescents with simultaneously crowded or spaced arches selected from a public high school, which could represent adolescents of both sexes between 12 and 16 years from low socioeconomic strata in Lima, Peru.

No sex differences for the tooth width ratios were observed. This has been previously reported by other authors.[18–23] It is interesting to note that if differences among mesiodistal tooth width in subjects with crowding and spacing exist, these would not be of the same magnitude for all teeth in both arches. When all these small differences are considered together, different values for tooth width ratios are obtained. Previously, Lündstrom[2] found that cases with large upper teeth in relation with the lower teeth presented a tendency to greater crowding in the upper arch. Cases of relatively larger teeth in one jaw than in the other should be more likely to produce greater crowding in the former than in the latter jaw. Recently, Heusdens et al[21] and Santoro et al[18] explained that the differences between their study populations and Bolton standards appeared because of the great variability in mesiodistal tooth width in some teeth (upper lateral incisor and lower premolars, respectively).

It must be noted that in this study dental casts in which both arches presented simultaneously crowding and spacing were selected. Tooth width ratios of the selected dental casts were not different compared with the tooth width ratios of dental casts with one arch crowded and the other noncrowded (anterior ratio, $P = .060$; total ratio, $P = .062$) or from the complete original sample[23] (anterior ratio, $P = .438$; total ratio, $P = .446$).

Both means of the tooth width ratios were higher ($P < .03$) in crowded cases, but when the ratios were grouped according to the number of SDs from Bolton proposed mean value, only when the ratio was between the mean and −1 SD for the anterior ratio and between one and two SD for both ratios, the difference between crowded and noncrowded dentitions was significant. A tendency to have more crowded cases with more than one SD from Bolton mean was observed. As has been discussed previously,[23] the use of SD from Bolton mean is not necessarily the best way to evaluate tooth size discrepancies from a clinical perspective. Previously, only Norderval et al[6] evaluated anterior tooth width ratios in crowded and noncrowded cases. They also found a higher anterior ratio in the crowded cases, even though their sample consisted of cases with posterior class I occlusion with slight crowding (-2.33 ± 1.36 mm). In this study, no consideration was made about the posterior occlusion, and the crowded cases had a larger mean discrepancy and a wider range of SDs (upper arch, -2.88 ± 3.04 mm; lower arch, -3.08 ± 2.24 mm). This sample should therefore be more representative from the actual values found in a regular orthodontic population. Norderval et al[6] did not evaluate the total ratio, so no comparison in this regard can be made.

With the purpose of finding clinical significance for these results, the sum of anterior and total mesiodistal tooth widths in both arches were calculated and subtracted. Although both sums were larger in crowded dentitions, all

differences were within the normal values proposed by Bolton. Differences between subjects with noncrowded and crowded dentitions were 0.39 and 0.51 mm for the excess of anterior and total upper tooth mass with respect to lower mass excess. Neither can be considered clinically significant. Proffit and Fields[24] stated that tooth width discrepancies less than 1.5 mm are rarely significant. Only larger discrepancies could create problems that need to be considered in treatment planning. A previous article discussed the clinical significance of the tooth width ratios evaluated with SDs and millimeters.[23] Also, Adams[8] made a comparison of the sum of tooth widths for each arch according to sex but also considered second molars. He found that the differences were significant for male individuals in both arches and for female individuals in the upper arch. He considered the second permanent molars for each arch sum, and he also used a sample of subjects with class I posterior relationships. No mean crowding was quantified for the crowded sample.

As it can be seen, the samples from studies of Nordeval et al[6] and Adams[8] were from subjects with good occlusions but with or without crowding. The sample used in this study should better represent the common cases seen in orthodontic private practices because it did not consider the posterior occlusion and a slight crowding (around two mm) as selection criteria. Although dental arches with and without crowding present significant statistical differences in tooth width ratios, these differences are too small to be considered of clinical significance (less than one mm).

CONCLUSIONS

- Statistical but no clinical differences (less than one mm) were found between tooth width ratios in Peruvian adolescents with crowded and noncrowded dentitions.
- No difference between tooth width ratios according to sex or interaction between sex and crowding was found.

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